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Century of Progress Through Sanitation

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Presented before a Joint Session of the Ohio Association of Sanitarians and the Engineering Section of the American Public Health Association at the Eightieth Annual Meeting in Cleveland, Ohio, October 22, 1952.

Long ago a wise man said: The past is the material the present is made of; we can know ourselves only as we comprehend our past. This is as true of scientific disciplines as it is of men. Here, then, are the historical building blocks—unfamiliar to many of us—from which modern-day public health engineering was created.

Rediscovering Our Heritage in Sanitation

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MAN AND HIS ENVIRONMENT

ALL living things react to their environments. The higher forms of life exert a limited kind of environmental control by avoiding the more unfavorable situations. Some of the more sagacious of the animal species, such as the insects and the burrowing animals, go further and build protective housing.

Looking backward through the long record of the human race and beyond, into the legends of folklore and even to the mute story of the relics of lost civilizations, we find that thinking man has ever been conscious of environmental influences upon his health and well-being. He seems to have passed successively through the stages of avoidance (cave life) and of crude artificial shelter, and finally to have undertaken positive control of his environment. The extent of this control, from the simple heating of the cave to the complexities of modern community living, has marked the stages of his civilization.

Sanitary science represents the collective knowledge of the human race on environmental influences as they affect health and well-being. It deals with environmental regulation and control largely through engineering procedures. The fundamental features of this control are the elimination of the unfavorable environmental contacts and the creation and strengthening of the favorable.

OUR ANCESTORS

We who are students and practitioners of sanitary science—the sanitarian, and the sanitary or public health engineer—represent a profession of ancient and distinguished lineage. Our concern for the study and control of the human environment as it relates to health is a fusion of similar concerns on the part of scholarly men of many callings down through the centuries.

Our engineering ancestral line is naturally the most extensive and the most conspicuous. Frontinus describes the water works of ancient Rome, the earliest of which dates back some three centuries before the Christian Era.[1]

Three centuries earlier Eupalinus is reported to have been celebrated for the skill with which he carried out works for the water supply of Athens and other

Grecian cities. One of his recorded accomplishments was to bring water from a distant source, by tunnel and conduits, to supply the fountains, pipes, and sewers of the city of Samos.

Earlier engineers, known only through excavation of their works, built the wells and conduits that supplied Jerusalem in the time of the Kings of Judah, ancient Tyre in Phoenicia, and cities on the island of Cyprus. Still more remotely, and before the era of written history, systems of vaulted drains were laid in Chaldea and early Egypt.

Vitruvius, the Roman engineer-architect of the period of the Emperor Augustus, was an early city planner. He wrote the *Ten Books of Architecture* in which he dealt with such general topics as planning relative to local sites, foundations and drainage conditions, orientation with respect to the compass points, and hollow walls for dampproofing. Book VIII deals with hydraulic engineering in its broadest connotation of water works engineering. It treats of finding suitable water, of rainwater and rivers, of the medicinal effects of hot springs and mineral waters, of the selection of water by observation and experiment, and also of aqueduct and pipe-line construction.

The Grecian Hippocrates we also claim as a sanitarian ancestor. His medical writings earned him the title "Father of Medicine," but his emphasis upon the environment and its relation to disease, upon prevention as equally important with cure, justifies our regarding him also as the great Philosopher Sanitarian.

Of Hippocrates it has been said, "He was the first to dissociate medicine from priestcraft and to direct exclusive attention to the natural history of disease," and, "His treatise on *Air, Water* and *Places* contains the first annunciation of the principles of public health." [2]

Some two thousand years later, in 1546, Hippocrates' views on air-borne infection and on the influence of "places" were echoed by Fracastorius in his *De Contagione*. This famous physician of Verona wrote, "Now of these contagions which come from without, the air is the most potent cause, though they may also come from water, marshes and other sources." [3]

But we claim Fracastorius as an illustrious ancestor in his own right because of the remarkable prescience shown in his description of the causative agencies of contagious diseases. He envisioned specific germs related to specific diseases. They exist in the air but as viscous matter, not like the simple vapors (gases). They "procreate other germs precisely similar to themselves, as progeny, which when carried to another object transmit the contagion to it."

To the extent that knowledge of causation is a prerequisite to prevention, the works of Fracastorius and of the great medical authorities that followed him have contributed to sanitary science. However, despite his acumen in the analysis of causes, Fracastorius devotes the remainder of his volume to curative treatment with no mention of prevention.

We have little difficulty in identifying in our ancestral line several distinguished chemists. Among these is Max Joseph Von Pettenkofer (1818–1901), the Bavarian chemist and hygienist. Because of his broad interests in the whole field of environmental sanitation he might well be termed the Father of Sanitary Science.

Pettenkofer devoted the early years of his life to studies in theoretical and applied chemistry. Among his varied activities he developed a process for the manufacture of illuminating gas from wood. His interest in sanitation became aroused by the unhealthy conditions existing in Munich. Thereafter, he devoted his major activities to studies on environmental conditions as related to health. His classic study on the

seasonal distribution of typhoid fever was of present-day epidemiological quality.

He wrote extensively and vigorously on pure air, pure water, and sewerage. He developed the Pettenkofer method for the determination of carbon dioxide in the air and, with Liebig, perfected a process for the condensation of meat extract, a product still to be found on our store counters and the forerunner of the whole line of condensed foods.

The great French scientist, Louis Pasteur (1822–1895), a contemporary of Pettenkofer, also began his scientific career as a chemist. He is best known to chemists for his discovery of the principle of stereoisomerism in tartaric acid. By some happy fate these chemical studies on a product of vinous fermentation brought him into contact with the fermentation industries and paved the way for his major life work, the study of the microbial agencies (ferments) of disease.

But our particular claim to Pasteur as a sanitarian is not that he was a great chemist and even a greater bacteriologist, but that his isolation and study of causative agencies of various diseases led him invariably to consider preventive measures. In the contemplation of his discovery of the yeast responsible for the fermentation of wine, he wrote, "Is it not permissible to believe, by analogy, that a day will come when easily applied preventive measures will arrest those scourges which suddenly desolate and terrify populations; such as the fearful disease (yellow fever) which has recently invaded Senegal and the valley of the Mississippi, or that other (bubonic plague), yet more terrible perhaps, which has ravaged the banks of the Volga?" [4] And, at another time, "You know that nowadays a medical knowledge of disease is nothing; it must be prevented beforehand." [5]

His early attempts at preventive treatments involved such diverse ills as a disease of the silkworm, the spoilage of wines and beer, cattle diseases, hog cholera, and anthrax. His methods included isolation of infected individuals, protective inoculation (vaccination), and heat treatment (pasteurization). His successes were spectacular.

Nevertheless, the opposition and the enmity of the medical profession was aroused by this encroachment upon their privileged field. Even the great Koch wrote disparagingly of Pasteur's views. At a meeting, in 1883, of the Académie de Médicine a Dr. Peters declaimed: "I do not much believe in that invasion of parasites which threatens us like an eleventh plague of Egypt. . . . Pasteur . . . is a chemist who has tried, out of a wish to be useful, to reform medicine to which he is a complete stranger . . . after so many laborious researches nothing will be changed in medicine, there will only be a few more microbes." [6]

Yet a few years later, at a meeting of the International Congress of Hygiene, M. Brouardel, dean of the Paris faculty of medicine, was able to say: "If echoes from this meeting could reach them . . . our ancestors would learn that a revolution, the most formidable for thirty centuries, has shaken medical science to its very foundations, and that it is the work of a stranger to their corporation. . . . We all proclaim ourselves disciples of Pasteur." [7]

At about this same time, in London, Sir Edward Frankland (1825–1899) was engaged upon what was probably the first scientific research in stream sanitation. Frankland, too, had been a theoretical chemist and had made some important contributions to the theory of valency among the chemical elements. He was appointed in 1868 to membership on the Second Royal Commission on River Pollution and spent two years on studies of methods of water analysis. Many of our current technics are based upon those studies.

As early as 1870 he investigated the

rate of oxygen loss from polluted water stored in a bottle. He noted that the reaction proceeded in an orderly manner and that time entered as a term in the purification equation. He lacked any knowledge of the biochemical nature of the reaction, believing it to be purely chemical oxidation, but his data on the rate of reaction are in striking accord with our present-day BOD values.

SANITARY SCIENCE

Genealogical research knows no limitations, but we may well pause at this point to inquire, what sort of individual is this sanitarian who is descended through such a diversified lineage? To whom and by what bonds is he related, and what is his place in the general public health plan?

Environmental sanitation is essentially an engineering enterprise; it deals with the forces of nature in the broadest sense. But its concern is chiefly with the impact of certain of those forces upon the health of man, a biological species, and some of the "forces" are themselves biological rather than physical.

Hence, many of the basic data of sanitary science are biological. The activities of the sanitarian are closely allied with those of specialists trained in the medical and biological sciences, the physiologist, the bacteriologist, the entomologist, the epidemiologist, the parasitologist, and others.

A rather detailed outline of the scope and objectives of sanitary science was drawn up about a century ago in what is now generally known as the Shattuck report.[8]

Shattuck was a Boston bookseller. His remarkable insight into the mists and the mysteries, which at that time surrounded the entire subject of epidemic and contagious diseases, was gained through reading, personal observation, and a philosophic analysis of the recorded and observable facts. He freely acknowledged his indebtedness to the investigations and writings of Sir Edwin Chadwick, barrister-at-law, Dr. Southwood Smith, and their colleagues in the various reports of the Poor Law Commissions of Great Britain.

These reports stressed two points. It was found that the death rates in places of concentrated populations, the cities and towns, were greatly in excess of those in the country, this excess being most marked among the "epidemic and contagious" diseases and in infant mortality. They also noted that the "sanitary state" of a city or town was correlated with its death rate. Southwood Smith wrote, "In every district in which fever returns frequently and prevails extensively, there is uniformly a bad drainage, a bad sewerage, a bad supply of water, a bad supply of scavengers, and a consequent accumulation of filth."[9]

Shattuck's definition of "perfect public health" is a condition which will "secure to man, associated in society the same sanitary enjoyments that he would have as an isolated individual; and as will protect him from injury from any influences connected with his locality, his dwelling-house, his occupation, or those of his associates or neighbors, or from any other social causes."[10]

Can we devise a better, more concise, albeit more comprehensive, description of sanitary science as we know it today? Public health itself has grown like a meandering stream with tortuous channels and ever-widening and often poorly defined banks; but the main current of this stream is still, as it was a century ago, environmental sanitation, the protection of the individual from the sanitary hazards which result from his association in society.

Despite his farsighted vision of our present-day sanitary science, Shattuck did not foresee its development into a unified subject of academic instruction and professional practice. The organiza-

tion of a general board of health, which he recommended and which was carried out in Massachusetts many years later, included two physicians, a counselor-at-law, a chemist or natural philosopher, a civil engineer, and two men of practical business experience. The physicians were to be men of practical experience, "thoroughly understanding sanitary science," and the businessmen "capable of investigating and fully understanding the principles of sanitary science." The engineer and the chemist were specialists. The one, "competent to plan and construct public works and sanitary arrangements of public buildings and private homes"; and the other to "investigate the influence of the elements on the production or prevention of disease."

SANITARY ENGINEERING

In the early nineties, Professor William T. Sedgwick at the Massachusetts Institute of Technology was conducting a course entitled "Sanitary Science and the Public Health" in which the concept of a unified science dealing with sanitation was given its first concrete expression. The contents of this course later appeared in his well known textbook.[11]

Suitable reference to Sedgwick's place in the history of public health will doubtless be given in one of the following papers, but the following appreciation by a distinguished public health worker is pertinent in this place. "Broadly speaking, Mr. Sedgwick's most distinctive field was sanitary engineering, considering the term 'engineer' in the broader sense that seems to be better expressed by the French term 'ingenieur' as one who devises methods, not merely methods of constructing and operating so-called 'engineering works' but equally methods of scientific study of basic problems. In this broadest and best sense of the word, Mr. Sedgwick himself and many of his graduates who are not technically 'engineers' are really sanitary engineers of an order not previously known or conceived . . . engineers of public health, men trained to forward the movement in actual practice." [12]

This early development of sanitary science in an engineering school emphasizes the fact that engineering was the original stem and remains the main trunk of applied sanitation. The tributary sciences, biology, chemistry, and the others, have been necessary to orient its objectives and direct many of its technics.

Water supply and sewerage are the earliest and best established among the strictly sanitary engineering practices, but the engineers who built the early works were merely hydraulic engineers versed in the laws of flowing water. Frontinus discusses water quality only in terms of temperature and clarity, noting that his predecessors had combined the waters of some of the nearby hot springs with others from cooler sources and had provided certain elementary sedimentation basins. The selection of spring water sources in preference to more available surface sources was traditional, based allegedly upon mythology but, doubtless, upon the more substantial teachings of experience.

As late as 1828 the charter of the Institution of Civil Engineers in London lists the construction of aqueducts and the drainage of cities and towns among the conventional activities of the civil engineer, but with no special sanitary connotation.

Baker says "association of impure water and disease is implied in the earliest historical records." He quotes Place to the effect that Sanskrit medical lore, probably dating back to 2,000 B. C., records storage in copper containers, sunshine, and filtration through charcoal as good water treatment practices; and another reference includes boiling and the application of pieces of

hot copper.[13] These matters, however, were of interest to the natural philosophers rather than the engineers, who were essentially builders.

It is difficult to say when the concept of the sanitary engineer, a specialist charged with the responsibility for environmental sanitation, had its beginning. Merriman has placed it in 1847 when, in London, it was first made compulsory to turn all sewage into drains or sewers.[14] But engineers always had been the builders of waterworks and sewers. Their works contributed to environmental sanitation, as we know it, but were not then differentiated from highways, fortifications, and other engineering works.

By 1874 convincing evidence had been accumulated on the water-borne characteristics of the specific "poisons" of typhoid fever and cholera by which these diseases were communicated from patient to new victim. Pasteur had outlined a broad pattern of infection and the bacteriologists were not long in isolating and identifying the specific microbial agencies of these and other infectious diseases.

We believe that modern sanitary engineering had its beginnings not with the hydraulic or structural design of water and sewerage facilities, but rather with the discoveries of the water-borne characteristics of enteric diseases which, in turn, led to studies of possible preventive measures. Sanitary engineering may be said to have reached adolescence in 1922 when a separate Sanitary Engineering Division was authorized in the American Society of Civil Engineers. It is still struggling toward maturity.

The first four-year undergraduate courses in sanitary engineering were established in two of our large engineering colleges around 1890. In that era sanitary engineering was still concerned primarily with hydraulic and structural design. It is not surprising that these earlier curriculums lacked comprehensive courses in chemistry, bacteriology, and parasitology, but the deletion of these subjects from subsequent programs is less excusable. Recently some undergraduate curriculums in sanitary engineering have been abandoned completely and others show diminishing offerings in chemistry and bacteriology during the past several decades.

During this interval the responsibilities of the engineer in environmental sanitation have been greatly expanded. The engineering approach to the purely public health aspects of water supply and sewerage had proved so successful that it was being applied in many other directions. This is exemplified in the expansion of the engineering activities of the U. S. Public Health Service. These began with mosquito control and were gradually extended into the areas of stream sanitation, water and sewage treatment, milk and shellfish sanitation, industrial and school hygiene (including ventilation and lighting), rodent control, and restaurant sanitation.

Progress has been along similar lines within other health agencies and in other fields of environmental health. The engineers' activities have been extended to include atmospheric pollution, noise reduction in cities, housing, swimming pool and bathing beach sanitation, and other environmental controls. Yet, as late as 1926, in a symposium entitled "Historic Review of the Development of Sanitary Engineering in the United States During the Past One Hundred and Fifty Years" the scope of sanitary engineering activities covered was limited to water works, sewerage and drainage, street cleaning and refuse collection and disposal, mosquito control and ventilation.[15]

In spite of the trend toward expansion, some sanitary engineers and even some sanitary engineering educators still regard sanitary engineering as a traditional branch of civil engineering which "deals primarily with the building

of structures or works."[16] It is still being recommended that programs of instruction and research in sanitary engineering be based on a first degree in civil engineering. It has been stated that "adequate knowledge of essential engineering subjects cannot be acquired without effective guidance and laboratory work, whereas the limited number of public health subjects that are of importance to engineers are readily acquired by self-study."[16] Is this statement really true? Is it likely that a sanitary engineer will acquire the necessary knowledge of bacteriology, parasitology, and chemistry by self-study any more readily than he will acquire a desired knowledge of soil mechanics, design in metals and timber, or construction methods and estimating in the same manner? One's answer to this question may well depend upon his interpretation of what is meant by "essential engineering subjects." It is agreed that such subjects as strength of materials, dynamics, statics, elementary electrical and mechanical engineering, plain and reinforced concrete design, and several others are essential both to civil and sanitary engineers; but these courses and others like them can be given in a four-year undergraduate curriculum while still leaving room for a considerable amount of instruction in bacteriology, parasitology, and chemistry through quantitative analysis. Many of us feel strongly that the latter subjects are "musts" in any sanitary engineering curriculum.

In the light of recent trends, it does not appear likely that all or even a majority of the sanitary engineering curriculums will soon become adequately strengthened in the subjects so essential in this field. The same situation exists today that was recognized by some as much as 30 years ago. At that time the term "Public Health Engineering" was coined as a means of differentiating between sanitary engineering in its narrow concepts and sanitary engineering in the broadened concept, as an area embracing the entire field of environmental sanitation. The longer term was employed largely as a defense mechanism, somewhat in protest against the narrower views within the profession. More particularly, however, it was conceived as a means of calling attention to the broadened scope of engineering in the rapidly expanding field of public health. The phrase is still being used for the same reasons. No doubt, it will continue to be used until the term "Sanitary Engineering" has some meaning other than that of being a traditional branch of civil engineering.[17]

CONCLUSION

In any rediscovery of our heritage in sanitation, it is going to be necessary to break away from some of the traditions. Many of the major advancements in sanitary engineering have been characterized by such breaks. Most of the scientists whose names are now eminent in the written history of sanitation—Hippocrates, Chadwick, Shattuck, Sedgwick, and all those others whom we claim as illustrious ancestors in sanitary science—are distinguished by their innovations and departures from the traditional. As sanitarians, sanitary engineers, public health engineers or, as some would have, engineers in public health, we are of one family with a rich heritage and keen awareness of the responsibilities that such heritage entails. We are, in truth, the Temple Guards, responsible for guarding the portals of the Temple of Hygea.

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Before he has scanned many paragraphs, the reader will have reached a sure and enthusiastic agreement with the title of this paper. At the close he will agree that, in some part, the essential greatness of the pioneers pictured in these intimate reminiscences has been handed on to us, of this generation, by a sort of direct serial transfer of the intellectual virus of that "Golden Age" of sanitation.

There Were Giants in Those Days

C.-E. A. WINSLOW, Dr.P.H., F.A.P.H.A.
Editor, American Journal of Public Health

"AMONG the blind, the one-eyed man is king"; and, to the student, the teacher of somewhat more than average stature may assume proportions more majestic than are justified by his actual capacity.

Yet, in the long perspective of half a century, it seems to me that the decades between 1890 and 1910 in Boston constituted one of the most remarkable periods in the history of public health. For more than half of that period I was a student and young instructor at the Massachusetts Institute of Technology, and I still feel that the men with whom I was associated there had attributes of real greatness.

The notable advances of the time were, of course, made possible by the applications of the new science of bacteriology. They were actually effectuated through a peculiarly intimate relationship between the Massachusetts State Board of Health and a remarkable group of pioneers on the Institute of Technology faculty. William T. Sedgwick, head of the Department of Biology at MIT was operating what was, in essence, the first school of public health in the world and graduating such students as E. O. Jordan ('88), G. C. Whipple ('89), G. N. Calkins and G. W. Fuller ('90), Allen Hazen and Morris Knowles ('91), Severance Burrage ('92), W. R. Copeland and D. D. Jackson ('93), Theodore Horton ('94), and Charles G. Hyde and S. D. Gage ('96). Thomas M. Drown was establishing the basis of sanitary chemistry and Ellen Richards was laying some of the foundations of home economics. In 1886 the Lawrence Experiment Station was set up under the guidance of Sedgwick and Drown. In the 16-foot cypress tanks on the banks of the Merrimac River, the basic principles of the oxidative purification of sewage were first developed; and the Lawrence City filters, in 1883, provided the first scientifically controlled demonstration of water purification. Sedgwick and J. H. Batchelder initiated work on milk bacteriology and began the long battle for pasteurization in 1892. Pioneer studies were made on water bacteriology and on that of ice, air and foods. In the Annual Report of the State Board of Health of Massachusetts for 1892, Sedgwick presented studies on typhoid fever epidemics at Lowell and Lawrence, at Springfield and at Bondsville, which were classics in the field and which make this one of the most outstanding volumes in the history of epidemiology.

On the public health side of this fruitful cooperation between a state and a university, credit must be given to Henry P. Walcott, president of the State

Board of Health. Tall and majestic, epitome of the highest qualities of Boston medicine, he was to us a distant and impressive figure, and perhaps really a giant. The secretary of the board, Charles Harrington, was no giant but a salty and a stimulating figure. I still recall sitting in the office of this tempermental Irishman and hearing his reaction to a telephone call, essentially as follows: "No, I'm sorry, I do not know. I have no information on that point. No! The clairvoyant's out." I never knew what the obstinate questioner wanted.

Another, more peripheral, figure in the group was Samuel H. Durgin, for many years health officer of the City of Boston. He was small, dainty, precise, and pedantic—always spoken of as "Sammy" but never so addressed to his face. On one occasion, at a public hearing, he was being baited because he had lifted the quarantine on a smallpox ship a few days before the usual limit. "Gentlemen," he said, rising a little on his toes and holding up both his hands like a pair of scales, "I hold the public health of Boston in one hand and its commerce in the other"—a wise maxim for the health administrator, if the scales are not allowed to tip too far.

On the engineering side perhaps the greatest figure was Hiram F. Mills of Lawrence, an outstanding member of the State Board of Health and prime mover in the establishment of the Lawrence Experiment Station. To me, as a youngster, he was little more than a name. George W. Fuller, Allen Hazen, and George C. Whipple, however, I came to know later intimately.

Fuller was certainly a giant in a physical sense, carrying his huge bulk with vigor and possessing a capacity for work — and for conviviality — which stood him in good stead in all night conferences with the city fathers he advised. He was a shrewd negotiator and an excellent businessman. He was responsible for notable pioneer studies of water purification at Louisville and Cincinnati, beginning in 1895. He rendered notable service as consultant to the Army on sanitation problems and served as an adviser on water treatment and sewage disposal to Chicago, New York, and 150 other cities of considerable size. He was, more than any other one person, responsible for the development of the *Standard Methods of Water Analysis* of the APHA and served as our president in 1928–1929.

Allen Hazen was of very different mold. Tall, angular, somewhat precise and pedantic, he had a mind which I think might fairly class him as an intellectual giant. Even before taking his degree at MIT he assisted Hiram F. Mills in preparing the plans for the Lawrence filter, and he was in charge of the Lawrence Experiment Station from 1888 to 1893. He developed the procedures for the mechanical analysis of sand, in use to this day. He planned the sewage disposal system for the Chicago Exposition in 1893. As a consulting engineer in Boston and later in New York he built the Albany (N.Y.) filter and consulted with many municipalities (including Brisbane, Australia) on water problems. His studies on hydraulics, on hydrography, and the runoff of streams were basic in the development of these areas of engineering.

George Whipple I knew even more intimately. He and I were members of the American Red Cross Mission to Russia (the Russia of Kerensky) in 1917 and we shared a luxurious state room in the Czar's imperial train from Vladivostok to Moscow. He was a loveable little man, full of interest in the small affairs of daily life. He was perhaps less of a giant than either Fuller or Hazen, but more widely known than either because of his membership in the triumvirate with Sedgwick and Milton J. Rosenau who established the Harvard Technology School for Health Officers in

1913, and for his *Microscopy of Drinking Water*, still the standard work in that field. (It is of some interest that the standard book on water bacteriology still in use after nearly half a century was also a product of these early days).

Whipple organized and directed the work of our two most distinguished water control laboratories, at Chestnut Hill in Boston and Mount Prospect in Brooklyn. He was Hazen's partner in the consulting firm of Hazen and Whipple and came to Harvard as a professor of sanitary engineering in 1911.

It may fairly be said that prior to 1890 we knew practically nothing of the actual scientific fundamentals of sanitary science; while by 1910, the basic principles of that science had been well and truly established.

This remarkable achievement was primarily made possible by the state of the art—that is, by the new avenues of research opened up by the young science of bacteriology. Visitors to Europe brought back the new technics developed by Pasteur in Paris and by Koch in Berlin. The Petri dish was something new. We demonstrated it to our students, but we also taught them to use the older method of pouring gelatin on a flat glass plate on top of a dish of ice to chill it and covered with a glass bell jar to shut out air contamination. The microscope was an unfamiliar tool in the sanitary field. I recall clearly a visit to the Lawrence Laboratory when I was studying the sewage streptococci. Lactose agar plates were coming into use, but all red colonies were regarded as "*B. coli.*" I pointed out the difference between the small deep red colonies of streptococci and the large paler colonies of colon bacilli and asked for a microscope to demonstrate the organisms themselves. "Microscope, microscope?" Yes, there was one on the upper shelf of a closet but it never had been employed in the laboratory routine.

The sanitarian at last had tools which could be used in the creation of a new science. "There is a tide in the affairs of men which taken at the flood leads on to fortune."

It took men, however, to use these new tools, and the Fates provided at MIT a remarkable group of pioneers to take advantage of the instruments developed by the emergent science of bacteriology. The titan of a galaxy of giants—the inspiring center of this new movement—was William Thompson Sedgwick.

Sedgwick himself was not primarily a laboratory investigator. He worked with men and with ideas, not with test tubes, but he fully realized the importance of basic scientific study. He picked his young assistants with care; he inspired them and criticized them. He gave them the opportunity and the stimulus to work. It was due to his leadership that the laboratories at MIT pioneered in the application of the new tools of science to water treatment and sewage treatment, to the bacteriology of water and milk, of ice and air and foods.

In epidemiology, Sedgwick played a more direct and personal role and he was, indeed, the first scientific American epidemiologist. Panum, Snow, and Budd had created this new science in Europe. In the United States, Benjamin Rush, Noah Webster and Daniel Drake had described epidemics and philosophized about them. In 1889 Smith and Kilborne had published their epoch-making experimental study of Texas fever. In this country, however, Sedgwick was almost the first to study the phenomena of epidemic prevalence by quantitative methods. His papers in the 1892 Report of the Massachusetts State Board of Health laid well and truly the basis for our understanding of water-borne diseases, of milk-borne diseases, and of contact-borne diseases. These studies alone place him in the first flight of American epidemiologists, ranking with Wade Hampton Frost as one of our two

leading exponents of this major branch of public health science.

Sedgwick was a pioneer in the task of interpreting the possibilities of the budding science of public health to the public. He was a crusader in a new and inspiring cause. His innumerable lectures and addresses and his book on *Sanitary Science and the Public Health* did much to attract recruits to this opening field and to secure community support for its future cultivation and expansion.

Finally—and most important of all—Sedgwick was an inspired and inspiring teacher. As a member of a group, one noted only a genial personality with the forehead of a scholar, but on the platform he was a notable figure. He was an exponent of what is today almost a lost art—that of lecturing. His addresses to large classes were apparently extemporaneous but actually prepared with meticulous care to produce a desired effect. In these lectures, as in his writings, he showed an unusual gift for the apt and perfect phrase. "The so-called 'germ' theory of disease is the child of fermentation and the grand-child of the microscope." Or again, "a sand filter is more than a mechanical strainer, and more than a chemical furnace, it is a breathing mechanism." In a lecture on the Boston water supply he noted, with regard to the microorganisms present that, "In one year each person would drink about 2264 feet of Asterionella, or nearly half a mile, 1635 feet of Tabellaria, 1392 feet of Melospira, 481 feet of Synedra, and 413 feet of Stephanodiscus. In other words he would drink a line of diatoms one and one-fifth miles long. This line, however, would nearly approach the mathematician's definition, for it has length without breadth and could be seen only with the aid of a microscope."

It was in small seminar groups, however, that Sedgwick's unique genius was best displayed, and the seminar is the heart and soul of any real educational process. He would start from some apparently quite casual point—an episode reported in the daily paper, perhaps. You never knew what would happen next. I recall after all these years a seminar in plant physiology devoted largely to a discussion of the question as to why Episcopalians have stained glass windows in their churches and Unitarians do not. In that hour we learned not only the function of the flower in the botanical world, but the general place of aesthetics in human life and society. An idea was tossed into the arena and its implications analyzed from every angle. The *Oxford Dictionary* was almost always called for to illuminate the exact meaning of words, a practice which I have found useful all my life. Sedgwick taught us to think clearly and to think deeply.

As I look back over the years there were two qualities of Sedgwick's mind and personality which made him a teacher of truly gigantic stature.

The first of these qualities was intellectual. It involved an almost passionate interest in exactitude as to words and the realities for which words stand and the relationships of words and facts in a universe which was always a connected and significant whole.

The second—and less obvious but more important—quality of Sedgwick as a man and as a teacher was a moral and spiritual one—his automatic assumption that the basic aim of the individual life was service to the common cause of human progress. Unlike his passion for clear thinking, this attitude was entirely unconscious on his part. He just took it for granted. I recall a long talk he and I had on my personal qualifications and failings, at the close of which he said, "On the whole, Winslow, I think you can be a very useful man." Not a successful man, not a prosperous man—a useful man. That was his measure of the value of human life.

At one time Sedgwick was appointed a member of the Board of Trustees of the Paupers' Institution of the City of Boston. The other members of the board were largely politicians of the old school and, as I had a chance to watch the deliberations of the board, it was most amusing to note their reactions to his suggestions. His automatic assumption that they were all there to further better care of their charges and for no other purpose, sometimes led to a dropping of the jaw and an interchange of surprised glances; but—at least while he was present—they played up to the role which he took for granted was inevitable.

Three of Sedgwick's students[1] have said that "The really great teacher must give to his pupil three different things: a vision of the subject in hand in its relations to the evolving universe, a vigorously honest method of thinking and working so that the truth may be adhered to and if possible advanced, and an enthusiasm for service which will prove better even than the desire for fame as the compelling motive to make men 'scorn delights and live laborious days.'" These three gifts, and in rich measure, Sedgwick bestowed upon his pupils.

I believe then that Sedgwick may truly be called a giant; but I think he would have wished me to point out that he did not create his attitude toward life out of whole cloth. Giants stand on the shoulders of giants. Sedgwick was the inheritor of a great tradition—the tradition of the late Victorians—of Matthew Arnold, of T. H. Huxley, and the rest. It was these men who developed the vision of a universe of natural law transfigured and given hopeful purpose by the process of evolution. It is a tradition to which he gave new life and a tradition which may still lead us out of the confusions of a changing world toward the sunrise of a new future for the human race.

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This tortured world of ours is so shrunken that we in America can no longer live unconcerned with pestilential threats to Asia, Africa, or the Near East. We owe it to ourselves as much as to humanity generally to help these less favored peoples—and ways to do the job are neither easy nor completely understood. New insights into world-wide problems are revealed.

Global Opportunity for a Better Environment

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THE rise of the United States to a position of world leadership has made it mandatory that Americans think of global health problems. It is becoming more and more obvious that we cannot have peace in a world that is divided between a relatively small proportion which enjoys a high standard of living and a large proportion which lives in poverty and is disease stricken. World leadership has brought with it a responsibility for world health. Many Americans know, from having served in the Armed Forces during World War II and in the Korean campaign, or from travels abroad in recent years, that a significant portion of the world's health problems are associated with unsatisfactory environmental conditions. In fact, it is hardly necessary to say that there are opportunities for a better environment, globally—even in the United States, Canada, and Western Europe environmental sanitation is not at a satisfactory level in all areas. In some regions of the world there has not been even a beginning of sanitary control of the environment.

DEFINITION OF ENVIRONMENTAL SANITATION

It should be remembered that sanitation and sanitary (or public health) engineering are not synonymous. While the sanitary engineer has one of the key roles in the control of the environment, he is only one member of a team that includes representatives of other professional groups, such as medical health officers, chemists, sanitarians, biologists, veterinarians, entomologists, and physicists, as well as persons engaged in personal health services—medical practitioners, nurses, medical social workers, midwives, etc.

Environmental sanitation has been defined [1] as "the control of all those factors in man's environment which exercise or may exercise a deleterious effect on his physical development, health and survival."

Environmental sanitation is one of the major branches of public health work. Fair [2] has said:

> A number of different services are employed in the maintenance of public health, particularly those of two professions: medical health services for repairing damage caused by unfavorable environmental conditions and for fitting man to his environment, and engineering health service, for controlling unfavorable environmental conditions and fitting the environment to man. The specialized branch that fits otherwise healthy men to their en-

vironment is called preventive medicine. The specialized branch of engineering which fits the environment to man is called sanitary engineering—or public health engineering.

MAGNITUDE OF THE PROBLEM

The attainment and maintenance of a reasonably satisfactory sanitary environment for the people of the world is indeed a huge task. The director-general of the World Health Organization has said that "one-fifth of all the deaths in the world are due to faulty environment." At the 1950 meeting of the Engineering Section of the APHA, van Zile Hyde [3] discussed the economic loss from preventable illness and death. You will remember that he stated: "The major health problem of the world is not death—it is chronic and repeated infections and infestations which convert man from a productive unit to a liability to society."

In many parts of the world environmental sanitation work has not even been started. Lanoix [4] recently said:

> Afghanistan offers a completely virgin field for work in Sanitary Engineering. Sanitary conditions are most primitive, even in the larger cities, and no health and sanitation personnel exists as yet in the country. The sanitary pit privy, the septic tank, the disinfection of water, etc., are totally unknown. This year, with the advice and technical guidance of the WHO, the Afghan Ministry of Public Health is constructing the country's first sanitary public latrine and septic tank with accompanying subsurface disposal field.

In certain so-called "underdeveloped" areas, new engineering works, such as irrigation and water-power projects may actually increase the health problems of the area. Macdonald [5] describes the adverse effects of irrigation schemes in Egypt on the bilharziasis rate and says: "The work may be largely nullified by the associated deterioration in health, although the nature of the disease concerned may not lead to the dramatic result of the previous example (malaria in Ceylon) namely the total frustration of the engineer's efforts."

Perhaps there is compensation in the fact that one of the important members of today's preventive medicine team is the public health engineer. He often prevents his brother designing engineer from making mistakes which damage the health of the public. Unfortunately, quite often he must still seek to correct or at least reduce the bad effects after the mistakes have been made.

By this recitation of huge need for environmental sanitation measures, there is no intention of implying that attainment of an improved environment is impossible.

Unfortunately, many persons have ignored the question by saying that the problems in many parts of the world are those of "tropical diseases." By implication they would have us believe that these diseases are not capable of control by methods which have proved successful in the temperate zones. A few years ago, Wolman [6] speaking of the so-called tropical diseases said, "They are neither tropical in origin nor restricted by latitude. Historic accident may emphasize their tropical location, but the conditions which engender them cannot be easily or accurately relegated to the tropics." In his last paper before his untimely death, Subrahmanyan [7] showed the marked effect that sanitation measures have had in reducing cholera in certain areas of India which have a high rate of endemicity. Winslow,[8] in his recent monograph, discusses some of the economic costs of sickness and death in the world today. He points out that some of the most dramatic results from preventive medicine measures have been in the field of environmental sanitation.

PRESENT-DAY PROBLEMS

Most of the problems of control of the environment are still with us in one form or another in some part of the globe. Only a few of them will be re-

ferred to specifically in this discussion. Some of them are as old as that of providing a water supply for a small village; others are as new as the disposal of atomic wastes. Some are as rural as the disposal of excreta from isolated dwellings; others are as industrial as the problems of atmospheric pollution and the disposal of wastes from factories.

It has become customary in the past few years to speak about American know-how almost in a manner which indicates that the sending of an American expert to a foreign country will immediately enable that country to take all steps necessary to solve its problems. This is obviously untrue. Almost invariably it is impossible to superimpose the methods and technics of one culture or another different culture. Methods which are quite satisfactory in the United States may be totally unsatisfactory in an Asiatic country because of differences in culture, technical development, and economic resources. It is fair to say that the permanent solution of the sanitation needs of any country will be one that utilizes to a large extent local material and local labor, and which does not deviate too widely from the established cultural pattern of the country. Below there is outlined briefly some of the problems the solution of which will result in a better environment, globally.

Water Supply—Here we have a paradoxical situation. There are, without question, a large number of engineers in the Western World who are completely capable of providing a solution to the water supply problem of any large city of 100,000 or more population. However, the method of providing a safe water supply for a small village of say 100 people in Africa or Asia has not been solved. It is not that methods used in the United States would not be satisfactory from a sanitary standpoint; it is that such methods in most cases would not be economically feasible. It is doubtful, for instance, whether it ever will be possible to import enough hand pumps and well casing to provide "United States" types of small wells for all the villages of Africa. Undoubtedly, local material and labor must be used and the best method of using this material requires a high degree of technical training and imagination. Perhaps we have too much of a preconceived idea of the correct solution. It is possible in some of these primitive communities that a well, which is separated from the excreta disposal device, cased with stone or brick, provided with a rope and bucket, and situated so that drainage is away from the well, might be a sufficient improvement to materially reduce the incidence of water-borne diseases. Perhaps in such communities, many of which are in countries which have no resources in ferrous metals, there should be a greater usage of clay products, since baking of clay is known to many primitive people. It is possible that even the use of clay vessels for filtration of drinking water has not been sufficiently investigated. With smaller piped water supplies, even if filtration is not possible, relatively crude chlorination can possibly provide enough protection to minimize water-borne dysentery and cholera. At this time, in many communities of the world, perhaps we shall have to be satisfied with measures which will reduce water-borne diseases by, say, 90 per cent. It should be remembered that many of the refinements now in use in the United States have been added in recent years and did not play a major part in the reduction on water-borne diseases in this country.

Excreta Disposal and Sewage and Waste Treatment—What has been said of water supplies is also true to a great extent of sewage treatment and excreta disposal. The big problem in excreta disposal is to find methods which are cheap, which utilize local material and labor, and which do not offend the pop-

ulace by varying from the cultural pattern of the community. A recent letter from a worker in the Middle East (John Buxell) stresses the important part which religious customs in that area play in the selection of excreta disposal measures.

In many parts of the world human excreta are used extensively for fertilization of the soil. Admittedly, there may be an advantage to be gained from the use of this nitrogenous material on the soil. However, no method for the use of human excreta for fertilizer has been developed which is completely satisfactory from the standpoint of sanitation and which is acceptable to the peasant.

As water-carriage sewerage systems are installed, the question of sewage treatment will become more and more important. In other parts of the world, as in the United States, selection of a proper method of sewage treatment will involve a sound engineering study. Industrialization is now bringing to many countries the new problem of treatment of industrial waste. It is to be feared that the countries which are now for the first time undergoing industrialization will repeat the mistakes in waste disposal which were made by the United States and Great Britain. In one country which the author visited recently, the prediction was made that one of the first deficiencies which would interfere with its industrialization would be the lack of unpolluted water.

Bilharziasis Control—It certainly is true that there is today no effective method of bilharziasis control. It is estimated that in the Eastern Mediterranean region alone there are from 20 to 30 million people who are affected by this disease which weakens a population already suffering from malnutrition. Again, at least in the Middle East, any effective method of control must take cognizance of the religious beliefs and customs of the people.

Fly and Insect Control—In many places of the world, fly control is still an unsolved problem. Certainly, with the demonstrated relationships between fly incidence and gastrointestinal and ophthalmic diseases, the value of effective fly control cannot be overemphasized. As Dr. Paul Russell of the Rockefeller Foundation has pointed out, perhaps the best solution to this problem will utilize a combination of sanitary measures, chemical methods, and natural biological control methods. All of these approaches need further study by investigators of high caliber. Despite the dramatic results which have been shown in the control of malaria, our other insect problems are not solved. It seems that, as our knowledge advances, we will find more and more ways in which insects are implicated in the transmission of disease to man.

Cholera Control—Cholera still remains a scourge and as Subrahmanyan [7] pointed out, even if all of the epidemiology of the disease has not been worked out it has been definitely established that improving environmental sanitation will reduce the incidence of this disease materially. Under the leadership of an American engineer (James Arbuthnot) the Government of Pakistan with the help of WHO is currently engaged in an interesting experiment to determine whether cholera can be reduced to an insignificant level by environmental sanitation measures.

WORK OF INTERNATIONAL HEALTH AGENCIES IN ENVIRONMENTAL SANITATION

International work in this field is carried on both on a multilateral and bilateral basis. Examples of multilateral agencies are the World Health Organization and the Pan American Sanitary Bureau (which is also the WHO Regional Office for the Americas). In this type of program there is an international staff and the program is determined by all of the member states on an equal

basis. The United States, for instance, has only one vote in WHO, just the same as Liberia. The environmental sanitation activities of WHO have been described by the author.[9] Bilateral programs are programs in which the United States enters into contractual agreement with another single government. It is the author's opinion that the multilateral approach is far superior to the bilateral. Programs such as those of WHO leave no doubt as to the recipient nation's being on an equal basis with all the member nations. Dr. van Zile Hyde [8] has advanced the reasons why a multilateral approach cannot now be used exclusively by the United States. He says "True multilateral internationalism cannot exist on a billion dollar level when only one country has billions. We are today building in the WHO the solid core around which can be built a great multilateral attack on the world's health problems. Meanwhile, we are continuing on direct joint activities."

TRAINING OF SANITATION PERSONNEL

The continued success of environmental sanitation programs in any country will depend upon the provision of at least a core of nationals of that country who are competent in the public health aspects of sanitary engineering. In this connection, the Expert Committee on Environmental Sanitation [1] states:

> The assumption, perhaps too widely made, that underdeveloped regions are not prepared for the services of the best-trained specialists in environmental sanitation can readily be contested. Countries of minimum resources are most in need of the highest expert service available, both for diagnosis of need and for planning of solutions. The relegation of these functions to less-adequately prepared persons results from a great misunderstanding of the complexity of the problems in environmental sanitation encountered in areas of low economic level. These problems require for their solution the impact of high intelligence, training, and experience, even when the number of persons possessing such qualifications is necessarily a minimum. It is unsound practice literally to send a boy to do a man's job.

Under the traineeship programs of the various international agencies a number of sanitary engineers from other countries are being trained in the United States. This is helpful if the traineeships are a part of an over-all plan for the development of the national health agency, and if care is exercised that individuals are not trained faster than their countries can absorb them. In the author's opinion, there should be more attention given to the development of training centers in other countries. In general, young men would derive more benefit if they were to receive their specialized public health training in regional training institutions where the environmental and social conditions approximate those in the areas where they will serve. Increased attention in the establishment and the strengthening of regional training centers might well be given both on bilateral and on multilateral bases. Countries such as the United States can make a significant contribution to such training institutions by sending to them teachers who are willing to remain in the region long enough to become familiar with the language and with the culture. Even after such regional training centers become available, experienced engineers, administrators, scientists, and teachers could still benefit by training outside their own region.

OPPORTUNITIES IN FOREIGN ASSIGNMENTS

A number of people have asked if service in foreign countries is a satisfying professional experience. The large majority of American sanitation personnel, both in bilateral and multilateral agencies, find the work most satisfying professionally. Many of them have indicated that they derive satisfaction from being able to do work which has

such measurable results. Those who have been most successful are men who are willing to learn from a country as well as to teach, who like to work with people, who do not have a feeling of superiority, and who attempt to understand and appreciate the culture of the country in which they are working. Certainly environmental health work abroad offers a challenge to our best men and it should be axiomatic that only our best men be sent to do foreign health work.

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As a cure for administrative complacency this frank review of present sanitary inadequacies and delinquencies may prove salutary. These environmental hazards we know how to surmount though we may not. Perhaps more disquieting is the paper's view of the future, revealing challenges we are as yet inadequately prepared to accept.

Environmental Health Responsibilities for the Next Century

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WE as a profession of engineers in public health can indeed be proud of our past performances. But we cannot rest on our laurels, particularly if we view the tremendous responsibilities which lie ahead of us in many of the underprivileged areas of the world. The present status of environmental health in many parts of this country, and in certain areas of most of our large cities, is enough to appall us and to indicate that there is an untold amount of work to be accomplished. Let us take a moment to question ourselves regarding the present state of environmental health.

Can we say that our job is finished when the records show that in the United States a quarter of a million persons were affected by intestinal disturbances attributable to water supplies in the years from 1920 through 1945? These are only the reported cases which represent a small fraction of the total number. Can we rest on our laurels when 6,000 persons were taken ill from air pollution in a small city in Pennsylvania in one week during 1948? Can we rest on our laurels when during this past year over 100 cases of encephalitis broke out in California when the mosquitoes got out of control? And again, can we rest on our laurels when about one million people are laid low in this country each year by "something they ate"? These are only some of the questions which we can ask ourselves. Each of you could furnish many other questions with which we could examine ourselves and our profession with a critical eye. The answer is obvious. Our record of past accomplishments is good, but the goal ahead is tremendous, even in this country which supposedly has one of the best records in environmental health.

In a discussion of some of our responsibilities for the future we could spend the allotted time on any one of our many fields of endeavor. However, it would be more advantageous to consider the broader aspects since the responsibilities placed upon the engineer in the field of environmental health are very broad and very great.

First let us consider the problem of handling wastes in such a manner that the environment will not be injurious to the health and welfare of the populace. Engineers in public health have knowledge of, and responsibility for the disposal of gaseous, liquid, and solid wastes. In the field of atmospheric

pollution and control we need not say much because we have not done much. I am not speaking of the field of industrial hygiene where notable progress has been made within the plant to protect the worker.

Think of all the work that lies ahead in order to clean up our atmospheric environment outside the industrial plant! But before we can accomplish much, even with the engineering methods now available, we need the cooperation of medical men, scientists of many categories, and engineers from several specialties. The medical profession must give us a better basis for evaluating the effect of air pollution. Industrial management thinks in terms of dollars and cents and has already accepted the fact that it pays to protect the health of men who operate machines. But what of the health of the community? We can tell industry how much it is going to cost to cease polluting the atmosphere, but in order to justify the expenditures involved they must be convinced of the return on their investment in terms of savings in lost man-days of work, improved health of the community, and a better living environment. We know of the disastrous effects of a few spectacular incidents of drastic air pollution, but what of the everyday effect of the discharge of gases and aerosols in the atmosphere of every city in our land? Toxicologists, epidemioiogists, and research workers from many disciplines are now working on this problem and it behooves us to give them the utmost cooperation. A great deal of teamwork lies ahead before the answers will be found. Then we can proceed to seek the cooperation of industrial management to clean up our atmospheric environment.

We have come a long way toward the abatement of stream pollution. But it has been estimated that in the next 20 years alone, it will be necessary for industries and municipalities to expend approximately 20 billion dollars in order to achieve a reasonable goal in stream pollution abatement. The responsibility of the sanitary engineer is not alone that of assisting in the enactment of adequate and fair legislation, and the enforcement of these laws, but also in the development, design, and operation of new and more economical methods for the treatment of sewage and industrial wastes.

Research teams of sanitary engineers, chemists, biologists, and chemical engineers must constantly strive for more effective utilization of the principles of the basic sciences so that our treatment plants may be smaller, cheaper, easier for men to operate, and also more rapid in their action. Like any other commodity, we cannot afford to price ourselves out of the market. Our processes have been getting more complex; whereas our aim should be toward simplicity and economy. If we can make our products, namely, our treatment processes, more attractive from the financial standpoint, we shall approach our goal of the abatement of stream pollution much more rapidly. Our responsibilities for the future in this field have been well delineated by many writers. It is up to us to fulfill them so that we may achieve our goal, not alone by legal action, but principally through cooperative endeavor.

Refuse disposal is a major engineering problem in most cities. It has been estimated that 8,000 communities need modern refuse disposal facilities in this country alone, not to mention the many other municipalities which are in need of modernization of equipment and methods. The trend in garbage disposal seems to be toward grinding and discharge into municipal sewerage systems. This is a sanitary method and, although expensive, is one which we as sanitary engineers are prepared to handle. Our responsibilities lie in assuring adequate sewerage systems and biological treat-

ment facilities for this additional organic load.

Handling other constituents of municipal refuse leaves much to be desired. Refuse collection in many cities is in a primitive state. Sanitary engineers have recognized their responsibility for the improvement of this condition. Investigations are now under way with the goal of putting refuse collection on an engineering basis. The significance of each factor involved, such as labor, equipment, haulage distances, household operations, and the others must be evaluated in order to make a true engineering operation of this highly important phase of environmental health work.

Much remains for the sanitary engineer to accomplish in the reclamation of organic matter in municipal refuse. Agriculturists all over the world are clamoring for more organic fertilizers and humus material with which to build up the soil in order to maintain high productivity. Composting of organic refuse is not new. Much engineering development lies ahead before the process can become attractive, both on an economical and a practical basis for municipalities. We have a responsibility to take part in this development and in so doing make available literally millions of tons of organic humus each year.

Great achievements have been noted in the field of milk and food sanitation. Through vigilance and extensive educational campaigns, sanitarians and sanitary engineers have succeeded in reducing the toll from milk-borne diseases quite remarkably. However, the hazards are ever-present and much research and development remains to be performed in striving for new pasteurization methods, applicable to a wider range of organisms. Our responsibility in the future lies not only in research and development work, but also in maintaining a strict policy of safeguarding all phases of milk production, processing, and handling. We must furnish leadership for a universal acceptance of the pasteurization of all milk for human consumption, for wider recognition and acceptance of a uniform milk ordinance and code, and for keeping such a code up to date and practical.

Much can be said about our responsibility in the field of food sanitation. We go to a great deal of trouble in the disinfection of water and milk supplies, but when reliable sources estimate that in this country there may be as many as one million enterotoxic cases a year attributable to the consumption of foods, our responsibility definitely stares us in the face. Sanitary codes are being well enforced in many cities by accomplished sanitarians. But there is still a great deal of engineering research to be done in restaurant sanitation in order to make the task of the sanitarian easier and more possible of accomplishment.

Think of the millions and millions of dishes which are washed each day in restaurants throughout this country. It is true that we have sponsored the application of modern disinfectants and detergents which have gone a long way toward solving the problem of dishwashing. But have we applied the best of our knowledge in the fields of hydraulics and process equipment design to this rather mundane problem? Take a look at present methods of desoiling, one of the most important phases of dishwashing. Just ahead of the shiny stainless steel washing and rinsing equipment comes the dirty manually operated desoiling and soaking sink. So much reliance must be placed upon the human element in this operation, and yet so much of the success in decontaminating the dishes depends upon this one operation that we have a paradox staring us in the face. It is our responsibility to work with sanitarians and equipment manufacturers to give them the best of our knowledge and make this task a more dependable operation.

Dishwashing is only one factor in our much greater responsibility of applying the best of our talents to improving the processing, serving and handling of foods in order that the present high incidence of food-borne infections may be reduced.

Much has been written concerning the role of the sanitary engineer in the control of insects and rodents. Progress within the past decade has revolutionized technics for the virtual eradication of malaria. Teamwork has been the key to the outstanding successes recorded in many parts of the world. Our responsibility is to continue this teamwork among tropical medicine personnel, epidemiologists, chemists, entomologists, sanitarians, health educators, and sanitary engineers, to seek constantly for more economical and more readily applied methods of insect control.

The present status of rodent control in this country leaves much room for improvement, to say nothing of conditions in many other parts of the world. Our future responsibilities in this field are indeed great—to encourage teamwork in the planning and supervision of programs for the effective utilization of new and powerful rodenticides, insecticides applicable to the killing of rat ectoparasites, and methods for the eradication of rat nests and feeding places. This brings us to the tremendous responsibility we now have and shall have in increasing measure in the future, for the hygiene of housing. Here is one of the greatest challenges to the collective abilities of professions concerned with environmental health. Public policy has been established by the Congress in the National Housing Act of 1949 with the statement that the "general welfare and security of the Nation and the health and living standards of its people require decent houses and a suitable living environment for every American family." Housing standards have been established and the present status of methods and technics of community planning and home construction have been delineated by the Committee on the Hygiene of Housing of this Association, with the cooperation of many agencies. Where do we go from here?

Our course is well charted by the sad state of so many houses in this country, to say nothing of the sadder state in other parts of the world. Crowded quarters, inadequate hygienic facilities, defective construction, poor lighting, heating and ventilating, and other factors well reported in our literature are all prejudicial to the physical and mental health and welfare of the occupants.

Measured in terms of public health, home accidents are a major source of disability and mortality. In the year 1948 alone reliable estimates showed that the total cost of home accidents, including medical expenses, costs of insurance and lost wages amounted to $700,000,000. Even by itself this startling figure should challenge our ingenuity and indicate our responsibilities for better engineering and more extensive programs of health and safety education. Further responsibility for the future lies in furnishing leadership and sponsoring support for the enactment and enforcement of rational housing standards, the construction of new housing, the rehabilitation of substandard housing and blighted urban areas, as well as adequate maintenance of approved housing.

Problems now unknown will also face us in the future. Take for example the tremendous growth of the nuclear industry and its attendant radiological problems virtually unheard of 10 years ago! Consider the problem of noise, both in industry and the community, with the advent of jet propulsion for aircraft. As workers in environmental health, our minds, our organizations, and our teamwork must be so flexible that we can readily grasp these new problems. New chemicals and new

processes all contribute to the environmental problems we must solve in sharing responsibilities for the future.

Last, but far from least, a discussion of our future responsibilities in the water supply field is in order. One important function will always be with us—to provide and maintain adequate, economical, efficient, and safe supplies of water. Much remains to be done to make these supplies even safer than they are at present in order to cut down sporadic outbreaks of water-borne diseases. In many of the underprivileged areas of the world enteric disease rates attributable to poor water supplies are appalling. Our responsibilities must include helping these countries obtain good water for their citizens by our technical and financial assistance.

When I was at the WHO Assembly in Geneva last May I asked one of the leading physicians of the Indian delegation, "What about Communism in India?" He replied, "Give me just one good deep well supply of water in each village in India and you will do more to combat the lures of the Communists than any other single factor. My people will not be so sick; they will be able to work their farms so they will not be hungry." "Remember," he said, "revolutions are not caused by those who are healthy and well fed, but by those who are sick and hungry."

Our water supplies have become complicated and expensive in this country where we can, perhaps, afford highly mechanized treatment plants. Many parts of the world look to us to develop simple and inexpensive means of securing good water, even where sources of good water are difficult to find. It is part of our responsibility to climb out of the limited sphere of our thinking and come up with new and courageous ideas.

This responsibility includes reclamation of sea and brackish water by simple means at costs within the realm of practical economics. Evaporation using fuels is expensive; vapor distillation is cheaper, but still high in equipment and fuel costs. Permselective membranes are under development and will soon take their place as economic demineralizers where power is available. Great promise lies ahead for the use of solar energy in the distillation of sea water. Principles have already been worked out by the basic scientists, but much engineering remains to be done to make the installations cheaper to build on a large scale and more reliable to operate. Pilot plants are now in operation and the day is not far off when many desert areas near the sea will use solar distillation. Listen to an extract from a recent plea received at the Massachusetts Institute of Technology from a high official in an Eastern Mediterranean country: "Any success in a low-cost utilization of the Near East's *most plentiful resource*, the sun, to produce the area's *most desperately needed* resource, water, is something to which all of us, who are concerned with the economic development of the Near East attach the greatest importance."

These are just some of our many responsibilities for the future. Our ability to fulfill these responsibilities will depend upon the thoroughness of our education, the aggressiveness of our research, the soundness of our engineering, the economy of our design, the reliability of our operation, and the genuine spirit of cooperation we throw into teamwork with administrators, scientists, engineers, sanitarians, sociologists, economists, health educators, the medical profession, and countless other professions. Professor Winslow has reminisced about the past half century with the topic, "There Were Giants in Those Days." Let us strive to fulfill our responsibilities so well that after the next half century others may be proud to look back at our accomplishments and say, "There Was Unsurpassed Teamwork in Those Days."

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